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FACTS AND FACTORS OF EVOLUTION.

The Causes and Course of Organic Evolution: A Study in Bioenergics. By Prof. John Muirhead Macfarlane. Pp. ix+875. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1918.) Price 17*s.* net.

THIS book is the outcome of a lifetime of biological reflection and investigation, and will be read with much interest. The author, who left Edinburgh for Philadelphia many years ago, was early disciplined in zoology, as well as botany, but it is to the latter that he has especially devoted himself as professor in the University of Pennsylvania. His treatise is erudite and careful, very instructive, even apart from its theories; it expresses the convictions of a patient and independent thinker; it states a number of piquant conclusions more or less peculiar to the author; and it is carefully written. It covers a very wide range—the origin of organisms upon the earth, the phylogeny of plants and animals, the evolution of morals and man, the ethical factor in organic evolution, the rôle of religion in the ascent of man, the competitive and the co-operative systems among animals and in mankind, the human environment as it has been and is, and the evolution yet to come. We must restrict our attention to a few of the salient features.

(1) Prof. Macfarlane notes that "energy, continuity, and evolution," which may be said to constitute "the triune basis of existence," form the keynote of his book. But all that is distinctive is the prominence given to "energy." The author recognises a series of forms of energy, which he calls thermic, lumic, tonic, chemic, molic or gravic, electric, biotic, cognitic, and cogitic. Biotic energy is associated with protoplasm in general, cognitic with chromatin, and cogitic with neuratin or Nissl substance. The terms "cognitic" and "cogitic" are far from happy, and it is of dubious utility to apply the physical concept of energy to certain aspects of vital activities which remain undescribed when a physical and chemical formulation has been given of the others. If it could be definitely stated—as it cannot—that the particles which ultra-microscopic examination shows in movement in a living nerve-cell are associated with a particular kind of energy, distinct from and yet in a line with such recognised energies as heat and electricity, then there would be an objective basis for a form of positive vitalism, similar to that held by some modern biologists, such as Prof. Marcus Hartog and the late Prof. Richard Assheton; but more evidence of the reality of "biotic energy" is required than Prof. Macfarlane adduces—more evidence than the usually admitted inability to give an adequate description of the most characteristic features of the activities of living creatures in physico-chemical terms. The living organism is a riddle imperfectly read, but our confidence in Prof. Macfarlane's contribution is not increased when we find two or three more particular forms of energy piled on the top of biotic.

(2) The author has discovered, he thinks, overlooked factor in organic evolution, which he calls proenvironment—"the resultant response of an organism to the sum-total of all the environal agents that act on it or on any part of it, and which causes the organism to proenviron a course or pathway that is temporarily *satisfying* to it, and that can alone be taken in virtue of the action of the several environal agents, and the reaction to each of these by appropriate organismal molecules." More briefly, Prof. Macfarlane defines the "law of proenvironment" as "the correlated resultant response by any body to the summated correlation of stimulatory action, that leads to a temporarily *satisfied* state." We rub our eyes; the so-called law of proenvironment takes us back to Herbert Spencer (with his emphasis on equilibrium and "effective response") and farther. Surely it is a commonplace that the lines taken by development and activity alike are resultants of environmental stimuli acting on living organisation which is internally determined by the inheritance and by previous experiences so that its responses are on the whole adaptive. We confess that we see very little in Prof. Macfarlane's discovery, and we doubt whether the capacity of giving a more or less satisfying unified response to a variety of external stimuli is a factor of evolution at all, except in the sense that every organism is a factor in its own evolution. It is a fundamental fact of life. The "five organic factors that are form-producing," the co-operative action of which is "pentamorphogeny," are Heredity, Environment, Proenvironment, Selection, and Reproduction. But there would have been heredity, environment, proenvironment, and reproduction though there were no evolution, and what would Darwin say to leaving Variability out of the Pentarchy?

(3) The author contends vigorously that "the main and dominant lines of animal evolution have all originated in fresh water or on land, and that only side lines have assumed a marine life, though these have often branched out profusely into species, and even have given off again groups that have in rare cases returned to a fresh-water or a land life." This is a good-going heresy, and the author supports it with learning and ingenuity. It is directly counter to the conclusion of most authorities, who hold that the probabilities are in favour of a marine origin of most of the phyla. Prof. Macfarlane makes out such a strong case that we feel how uncertain these speculative conclusions are. In our ignorance of the actual beginning of most of the phyla it is difficult to prove the erroneousness of the view that the buds were in fresh water, though the blossoms may have been in salt. We submit, however, a few considerations:

(*a*) At this distance of time appeals to present-day numbers of fresh-water and marine species in any particular phylum cannot be of much value in reference to origins, but there is some utility in thinking of the numbers of types in the two habitats, and of cases where the enormous majority of the types in a phylum are in the one or the other. Now, if we begin with the lowest phyla of Metazoa, the Sponges and Cœlentera, we find in both cases the vast majority of types in the sea and a very small minority in fresh water. The most natural—though not inevitable—inference is that the present-day habitat of the vast majority is the original habitat. The Echinoderms represent a well-defined phylum, all the living representatives of which are marine. The types at the base of the Chordate phylum—namely, Enteropneusts, Tunicates, and Lancelets—are all marine, which is again significant. Many similar cases might be given, but Prof. Macfarlane advances counter cases, and actual demonstration is out of the question.

(*b*) If we take a number of notable advances, such as paired unjointed limbs or parapodia, such as body-segments or metameres, such as genuine pre-oral appendages, such as the annulate or the chordate type of nervous system, such as true gill-clefts, such as a dorsal axis, and ask where they began, the evidence from present-day forms and from palæontology is on the whole in favour of the answer: In the sea. But Prof. Macfarlane brings forward counter instances, and no doubt the fresh waters have been a very educative school of life.

(*c*) Types with direct life-histories are very generally, though not always, less primitive than related types with larval stages, and the tendency of fresh-water animals to have little in the way of larval stages (telescoping these, according to our theory) is very striking except along a few lines, such as that of aquatic insects, which are no doubt primarily terrestrial. And it is not difficult to see why it should be so.

(*d*) For most of the types of fresh-water animals it is possible to give a plausible pedigree, starting from marine or terrestrial forms.

(*e*) It is a significant fact, emphasised by Quinton, that the blood of land animals, such as mammals, is in the proportion of sodium, potassium, and calcium ions almost identical with sea-water. It is difficult to interpret this except as a hint of pedigree.

(4) It is impossible to do justice in a few lines to Prof. Macfarlane's long discussion of the phylogeny of animals. He regards Rotifers—in spite of the specialisation of most of them—as "the foundational group" of the simpler Metazoa, and he has the hardihood to place a ciliated Infusorian and a Rotifer side by side, for "the lines of stereogenesis in the Rotifera remain fundamentally as in ciliate Infusoria." We do not profess to know much about stereogenesis, but the juxtaposition of a Rotifer not only with an Infusorian, but also with a larval Entomostracan and a larval Gastropod strains our morphological faith. It must be a foundational creature indeed which is like three things so different. The author traces the main line of ascent from the Rotifers through Turbellarians, Nemerteans, Cyclostomes, Cæcilians, to Marsupials and higher Mammals. The difficulties involved in side-tracking Tunicates and Lancelets and in dragging Cyclostomes and Cæcilians on to the direct line of ascent seem to us to be insurmountable. But this is largely a matter of opinion. It seems to be truer of phylogeny than of statistics that if you pick your data you can prove anything you like. There are, naturally enough, some loose ends in Prof. Macfarlane's arguments. These are of two kinds—matters of fact, as when he says that the eggs of Cyclostomata undergo holoblastic segmentation, which is not true of Myxinoids; and matters of interpretation, as when he says of the Cæcilians: "the active gliding habits and slippery skin, also, scarcely serve to set up the needed irritable stimuli that would start paired limbs as a response-result." This surely verges on the poetical.

(5) A useful chapter on "higher" animals expounds the not unfamiliar idea that along different lines and at different structural levels animals rise to approximately equal complexity of behaviour. Thus octopus, spider, ant, crow, and elephant are types that rise high along different lines of structural advance. This is sound enough, though it is time that Sir Ray Lankester's distinction between the "little brain" and the "big brain" types of cleverness was recognised in all such comparisons, but what seems to us quite in the air is Prof. Macfarlane's theory that the "energising stimuli" of a complexified environment excite the biotic system of the body and the cogitic cells of the brain to new adjustments and adaptive changes, "all of which are more or less shared by and influence the generative cells, which in turn affect the succeeding organisms hereditarily." In other words, without any submission of evidence, we are asked to return to the credulity of Lamarckism. The author says: "To repeat once more our fundamental position: flows of energy, often and steadily repeated from sense-collecting centres, start stereo-energetic stimulation-acts, that inevitably affect the brain-cells, and these by expenditure of cogitic energy give rise to proenvironal responses that constantly tend to place the organism for the time being in 'satisfied' relations to its environment." In so saying he seems to us to be stating with unnecessary technicality the fact that living creatures adjust themselves within limits to their surroundings; but when he suggests that the elephant's trunk evolved by the transmission of the results of individual "proenvironal reponses," we feel bound to say "napoo."

(6) In regard to the Ascent of Man, the author lays emphasis (as Anthony, Wood Jones, and others have done) on the evolutionary importance of the emancipation of the hand which "stimulated the brain to increased flows of energy and so increased complexity and growth." "In all such advance by environal stimulation-action and brain reaction, followed by proenvironal outreach-

ing and succeeding response, the great law of proenvironment is constantly at work." Again, we have the same fallacious hysteron proteron. Surely the emancipation of the hand was the outcome of variations of structure and habit which are left unexplained (not that *we* can explain them); surely the cerebral initiative that put the free hand to manifold tests and found for it a thousand uses was and is a cause, not a consequence; moreover, the hereditary entailment of individual gains is a hypothesis, not a proven fact. We wish to make clear that when Prof. Macfarlane speaks of "the capacity of an organism for perceiving and then positively growing or moving toward an environment that is most satisfying for it," he is not defining any new "law of proenvironment," but referring to the fundamental fact that the organism is a self-preservative agent. In so far as other evolutionists have forgotten this and made the organism a passive pawn in a game, or a portmanteau of potentialities which require only liberating stimuli, Prof. Macfarlane's thesis is of great service. He has hold of the open secret that the organism shares in its own evolution.

(7) Our admiration is commanded by the two chapters in which the author gives an appreciation of the two great ways—competitive and co-operative—in which organisms answer back to the difficulties and limitations that beset them, though we do not think he realises what Darwin clearly expressed, that a co-operative reaction to a crisis is as much part of the struggle for existence as a competitive one. We wish that we had space to refer to the concluding chapters on human evolution, which are marked by a splendid earnestness and a truly evolutionistic hope. We can only refer to the cope-stone of Prof. Macfarlane's hierarchy of substance. Just as biotic energy is associated with protoplasm, cognitic energy with chromatin, cogitic energy with neuratin, so there is "spiritic energy"—a still more condensed mode—which "has so functioned as to energise the more aspiring and lofty souls of humanity to widest outreachings, toward the most profound questions of the world and the universe." "The phenomena, the experiences of human life in the past millennia especially, powerfully suggest to the writer that built up on, energised by, linked into complex relations by, a combined bio-cognito-cogitic union is a still more complex substance than the protoplasmatin, chromatin, or neuratin, probably resident in some part of the gray frontal matter of the brain, and which hypothetically we may call the *spiritin*." No man understands his brother's philosophy, and we do not know what Prof. Macfarlane is getting at by his quaint and uninviting system of substances and energies. There may be some, however, to whom it makes the riddle of the organism—body-mind and mind-body—clearer; and we are sure of this, that there are facts enough in the volume to reward even the learned, and that the whole work is marked by resoluteness and sincerity.

J. A. T.

AMERICAN UNIVERSITIES.

(1) *The America of To-day. Being Lectures delivered at the Local Lectures Summer Meeting of the University of Cambridge,* 1918. Edited by Dr. Gaillard Lapsley. Pp. xxv+254. (Cambridge: At the University Press, 1919.) Price 12*s.* net.

(2) *The Voyage of a Vice-Chancellor.* Pp. ix+139. (Cambridge: At the University Press, 1919.) Price 6*s.* net.

(1) THIS volume of lectures delivered at Cambridge in the summer of 1918 contains only two chapters of direct technical interest to the readers of NATURE—namely, that of Prof. J. W. Cunliffe, on "American Universities: their Beginnings and Development," and that by Dr. G. E. MacLean on "State Universities, School Systems, and Colleges in the United States of America." The first of these gives a very interesting account of the English origins of American universities, of the effect of the different environments in bringing about a gradual departure from the English model, the injection of German influence, and the subsequent growth along more independent lines. The similar process of development is traced by Dr. MacLean with respect to the State-supported institutions, which have no direct counterpart in Great Britain. A very clear account is given of the various ways in which State and federal subsidy is provided for these institutions, and there is a brief discussion of the type of administrative organisation which has grown up. Both Prof. Cunliffe and Dr. MacLean rightly emphasise the ideals of universal education which have led to such a large expenditure of public money upon the school system as a whole. The result is, perhaps, that the reader unfamiliar with the situation would get too rosy a picture of the state of affairs. Not that there is any loss of faith in the ideals, but that, as Dr. MacLean points out, there is a strong feeling that great changes of method are necessary, and, indeed, such changes are constantly under discussion and under trial. Though they have no direct bearing on the subject of education, chaps. iii. and iv., by Lord Eustace Percy, on "State Municipal Government" and "Social Legislation," read in conjunction with those on education, will give a fairer idea of the tremendous problems presented by education in America and of the political and social difficulties involved in their solution.

(2) Such an important journey as that of the British University Mission in the autumn of 1918 to Canada and the United States will doubtless be the subject of formal and formidable reports both in England and America, but it is well to have also such an intimate and clever personal record of daily happenings as Dr. Shipley has given us in this volume. Though the account, in diary form, is very brief, one gains a clear impression of the differing characteristics of the various institutions and regions which were visited. As one reads of the unbroken series of banquets and